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भारत सरकार
जल संसाधन मंत्रालय
केंद्रीय भूजल बोर्ड

GOVT OF INDIA
MINISTRY OF WATER RESOURCES
CENTRAL GROUND WATER BOARD

महाराष्ट्र राज्य के अंतर्गत चंद्रपुर जिले की भूजल विज्ञान जानकारी

GROUND WATER INFORMATION
CHANDRAPUR DISTRICT
MAHARASHTRA

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CENTRAL REGION
NAGPUR
2013

CHANDRAPUR DISTRICT AT A GLANCE

1. GENERAL INFORMATION

Geographical Area		10920 sq. km
Administrative Divisions (As on 31/03/2007)	:	Taluka- 15; Chandrapur, Warora, Chimur, Nagbhid, Brahmapuri, Sawli, Sindewahi, Bhadravati, Mul, Pobhurna, Ballarpur, Korpana, Rajura, Gondpipri and Jivati
Villages	:	1791
Population	:	21,94,262
Normal Annual Rainfall	:	1200 to 1450 mm

2. GEOMORPHOLOGY

Major Physiographic unit	:	2; Plain region in river valleys of Wardha, Penganga and Wainganga rivers and Upland hilly region
Major Drainage	:	3; Wardha, Penganga and Wainganga

3. LAND USE (2005-06)

Forest Area	:	4080 sq. km.
Net Area Sown	:	4580 sq. km.
Cultivable Area	:	5050 sq. km.

4. SOIL TYPE

Three types of soils, Shallow coarse, Medium black and Deep black

5. PRINCIPAL CROPS (2005-06)

Cereals	:	2045 sq. km.
Pulses	:	659 sq. km.
Oilseeds	:	1372 sq. km.
Cotton	:	561 sq. km.

6. IRRIGATION BY DIFFERENT SOURCES (2006-07)- Nos./Potential Created/Potential Utilised (ha)

Dugwells	:	20922 / 41002 / 34058
Tubewells/Borewells	:	1655 / 3954 / 3224
Surface Flow Schemes	:	2637 / 41582 / 34686
Surface Lift Sources	:	2626 / 8140 / 6795
Net Irrigated Area	:	106700

7. GROUND WATER MONITORING WELLS (As on 31/05/2011)

Dugwells	:	48
Piezometers	:	11

8. GEOLOGY

Recent	:	Alluvium
Upper Cretaceous-Lower Eocene	:	Deccan Trap Basalt
Upper Carboniferous –Triassic	:	Gondwana
Pre-Cambrian	:	Vindhyan
Archean	:	Crystalline and Older metamorphics

9. HYDROGEOLOGY

Water Bearing Formation	:	Hard Rock: Archean- Weathered and fractured granite and granitic gneisses; Vindhyan- Cavernous and fractured Limestone; Deccan Traps- Weathered/Fractured/Jointed massive or vesicular Basalt Soft Rock: Gondwana- Kamthi and Barakar sandstone; Alluvium- Sand and gravel.

Premonsoon Depth to Water Level (May 2011)	:	1.70 to 16.32 m bgl
Postmonsoon Depth to Water Level (Nov. 2007)	:	1.00 to 13.55 m bgl
Premonsoon Water Level Trend (May, 2002-2011)	:	Rise: 0.01 to 0.36 m/year Fall: Negligible to 1.49 m/year
Postmonsoon Water Level Trend (Nov., 2002-2011)	:	Rise: 0.01 to 1.24 m/year Fall: Negligible to 0.48 m/year

10. GROUND WATER EXPLORATION (As on 31/03/11)

Wells Drilled	:	EW-50, OW-31, Pz-11
Depth Range	:	18.00 to 450.54 m bgl
Discharge	:	0.55 to 33.50 lps
Transmissivity	:	18.00 to 700 m^2/day (Gondwana Sandstone)

11. GROUND WATER QUALITY

Good and suitable for drinking and irrigation purpose, however localized nitrate and fluoride contamination is observed.

Type of Water	:	Predominantly Ca-Cl

12. DYNAMIC GROUND WATER RESOURCES- (As on 2008-09)

Net Annual Ground Water Availability	:	1029 MCM
Annual Ground Water Draft (Irrigation+Domestic)	:	150 MCM
Allocation for Domestic and Industrial requirement up to next 25 years	:	126 MCM
Stage of Ground Water Development	:	14.61%

13. AWARENESS AND TRAINING ACTIVITY

Mass Awareness Programme	:	Two
a. Date	:	18/06/2003 & 02/02/2012
b. Place	:	Anadwan & Mul
c. Participants	:	200 & 250
Water Management Training Programme	:	Nil

14. ARTIFICIAL RECHARGE & RAINWATER HARVESTING

Projects Completed	:	Nil
Projects under Technical Guidance	:	Nil

15. GROUND WATER CONTROL & REGULATION

Over Exploited Taluka	:	None
Critical Taluka	:	None
Notified Taluka	:	None

16. MAJOR GROUND WATER PROBLEMS AND ISSUES

The major parts of the district are showing falling ground water level trends mainly in north eastern, central, south western and south eastern parts of the district comprising almost entire Brahmapuri, Nagbhid, Sindewahi, Saoli, Mul, Gondpipri, Jiwati, Korpana, Chandrapur and Warora talukas. The ground water quality is mainly affected by nitrate as 48% of samples are having high nitrate concentration. Apart from these, the ground water quality is getting affected due to industrial pollution in and around Ballarpur paper mill, whereas fluoride contamination is also observed in parts of Rajura, Korpana, Warora and Chimur talukas of the district.

Ground Water Information
Chandrapur District

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Ground Water Information
Chandrapur District

1.0 Introduction

Chandrapur district is one of the eleven districts of Vidarbha region of Maharashtra. It is bounded on south by Andhra Pradesh State, east by Garhchiroli district, on north by Gondia, Bhandara, Nagpur and Wardha districts on west by Yavatmal district. Wardha River forms the western boundary, whereas Wainganga River forms the eastern boundary of the district. The district lies between 19°30' and 20°45' north latitudes and 78°46' and 80°00' east longitudes. It falls in parts of the Survey of India Toposheet No. 55H, 55L, 56E and 56I covering an area of 10920 sq.km.

The district headquarters is located at Chandrapur Town. For administrative convenience, the district is divided in 15 talukas viz. Chandrapur, Warora, Chimur, Nagbhid, Brahmapuri, Sawli, Sindewahi, Bhadravati, Mul, Pobhurna, Ballarpur, Korpana, Rajura, Gondpipri and Jivati. It has a total population of 21,942,262 as per 2011 census. The district has 14 towns and 1791 villages out of which 349 villages are unhabitated. The district is well drained by Wardha and Wainganga rivers and their tributaries.

Central Ground Water Board has taken up several studies in the district. A list of studies conducted in the district is presented in **Table-1**.

Table 1: Studies undertaken by CGWB.

S. No.	Officer	AAP	Type of Survey/Study
1.	Shri V.V.S. Mani	1972-73	Systematic Hydrogeological Survey
2.	S/Shri A.B. Deshmukh, J.N. Rai and Miss P. Tripathi	1975-76	-do-
3.	Shri D. Elangovan	1978-79	-do-
4.	Shri N. Somasundaram	1980-81	-do-
5.	Shri D. Elangovan	1981-82	-do-
6.	Shri K.N. Murthy	1984-85	-do-
7.	Shri D. Joshi	1991-92	Reappraisal Hydrogeological Survey (900 sq. km. area)
8.	Shri S. Bhattacharya	1992-93	-do- (300 sq.km.)
9.	Shri Binoy Ranjan	1993-94	-do-
10.	Shri S. Marwah	1993-94	-do-
11.	Shri S.K. Bansal	1994-95	-do- (In parts of Chandrapur, Bhadravati and Warora talukas)
12.	S/Shri B.N. Dehury, J. Davithuraj and S.K. Bansal	2001-02	Ground Water Pollution study around Ballarpur Paper Mill, Ballarpur
13.	Shri Binoy Ranjan	2005-06	Reappraisal Hydrogeological Survey

To explore the ground water potential and to determine aquifer properties, exploratory drilling was undertaken by the department from the year 1976 to 1991 in three phases. A total of 50 Exploratory Wells (EW) and 31 Observation Wells (OW) wells were drilled/constructed. In addition to these 11 Piezometers (Pz) were also constructed for monitoring of ground water levels. In Phase-I (1976), detailed ground water exploration by constructing well fields was carried out in Mahakali Colleries (8 wells) and Durgapur Colleries (12 wells) in Kamthi and Barakar sandstones. In second phase (1983), 9 deposit wells were constructed in north western part of the district in Lower Gondwana formation to supply drinking water to scarcity villages, whereas the remaining wells were drilled/constructed in third phase (1987-1991). The details of ground water exploration are presented in **Table 2**

Table 2: Salient Features of Ground Water Exploration.

S. No.	Taluka	Formation /Aquifer	Wells			Depth (mbgl)	SWL (mbgl)	Discharge (lps)	Zones (mbgl)
			EW	OW	PZ				
1.	Bhadravati	Gondwana/ Sandstone	2	0	2	73.80 – 251.87	11.05–40.00	1.05 – 4.00	8.84 – 81.08
		Vindhyan/ Limestone/ Sandstone	2	2	0	35.22 – 449.35	7.16 – 8.60	0.55 – 10.42	20.00 – 240.00
2.	Bramhapuri	Alluvium/ Sand	3	0	0	18.00 – 25.70	3.22	3.00	6.00 – 20.00
		Archean/ Fr. Gneisses	2	2	0	24.40 – 164.25	4.30	13.50	12.00 – 164.00
3.	Chandrapur	Gondwana/ Sandstone	7	17	3	24.90 – 450.54	6.60 – 15.85	1.00 – 33.50	0.65 – 429.00
4.	Chimur	Archean/ Fr. Gneisses	2	0	0	200.00 – 238.00	9.30 – 11.54	-	30.73 – 238.00
5.	Gondpipri	Gondwana/ Sandstone	4	0	1	57.50 – 103.00	6.36 - 10.10	0.73	25.00 – 101.00
		Archean/ Fr. Gneisses	4	1	0	129.40 - 293.30	2.13 – 6.08	0.78 – 2.16	-
6.	Mul	Archean/ Fr. Gneisses	2	1	0	151.00 - 191.00	1.75 – 6.10	0.78 – 2.18	36.85 – 39.85
7.	Nagbhid	Archean/ Fr. Gneisses	1	0	1	40.00-304.00	9.46	-	-
8.	Rajura	Archean/ Fr. Gneisses	2	2	0	153.00 – 300.00	8.70 – 11.35	1.37 – 11.37	-
		Vindhyan/ Limestone/ Sandstone	4	0	0	57.25 – 201.55	5.45 – 34.50	0.74 – 0.78	31.00 – 42.00
		Gondwana/ Sandstone	0	0	1	42.00	-	-	-
9.	Sindewahi	Archean/ Fr. Gneisses	4	3	0	110 – 211.75	3.17 – 7.50	0.78 – 10.37	18.80 – 257.75
10.	Warora	Archean/ Fr. Gneisses	1	1	0	140.60 - 196.00	2.00	1.00 – 8.00	-
		Gondwana/ Sandstone	8	1	0	71.00 – 300.00	3.65 – 11.46	2.16 – 18.00	6.70 – 125.00
		Deccan Trap/Basalt	2	1	3	40.00 – 300.00	3.15 – 8.65	1.05	-
	Total		**50**	**31**	**11**	**18.00 – 450.54**	**1.75 - 40.00**	**0.55 – 33.50**	**0.65 – 429.00**

Ground Water exploration was aimed at delineating the productive aquifers and ground water worthy areas down to the depth of 450 metres below ground level (m bgl) in unconsolidated formations viz., Sandstone/Alluvium and up to 300 m bgl in consolidated formations viz., Fractured Gneisses/Basalt. The yield ranges from 0.73 litres per second (lps) to 33.50 lps for a maximum drawdown of about 35 m in unconsolidated formations and 0.55 lps to 13.50 lps for a maximum draw down of about 28 m in consolidated formation. Productive zones in unconsolidated formations are observed down to 429 m bgl, whereas in consolidated formations they are observed even down to 257.75 m bgl.

A map of the district showing the taluka Boundaries, Taluka headquarters, physical features and location of exploratory and monitoring wells is presented as **Figure-1**.

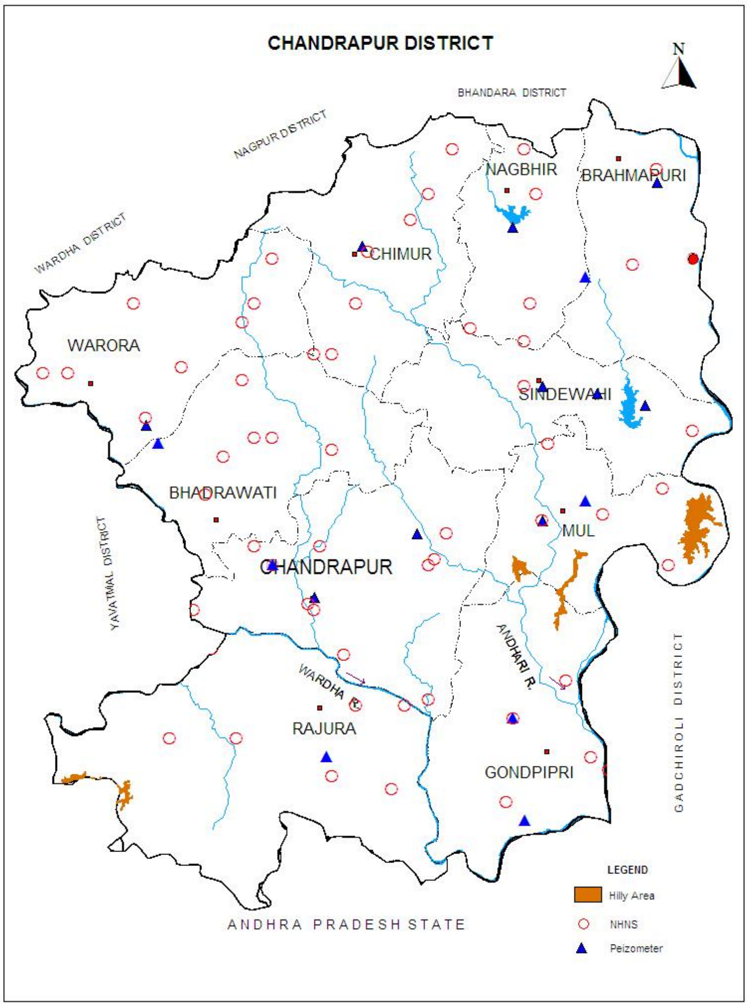

Figure 1: Location

2.0 Climate and Rainfall

The Climate of the district is characterised by a hot summer and general dryness throughout the year except during the south-west monsoon season, i.e., June to September. The temperature rises rapidly after February till May, which is the hottest month of the year. The mean daily maximum temperature during May is 42.8°C and the mean daily minimum temperature during December is 12.2°C

The normal annual rainfall (1901-1992) varies from about 1200 to 1450 mm. It is minimum in the western part around Warora and gradually increases towards east and reaches maximum around Brahmapuri. The study also reveals that large areas in central part of the district comprising parts of Chimur, Bhadravati, Chandrapur, Mul and Sindewahi experienced droughts for more than 20% of the years and can be categorized as “drought area”. The average annual rainfall for the last ten years 2002 to 2011 ranges from 871 mm (Bramhapuri) to 636 mm (Chimur). Further it can also be observed that 2003, 2005, 2006, 2007, 2008, 2010 and 2011 have been normal/above normal rainfall years, whereas remaining years have been below normal rainfall years. It is noticed that the average annual rainfall has decreased during the last 10 years period as compared to the normal annual rainfall. The data is presented in **Table-3**. It is noticed that the average annual rainfall during the last 10 years period is almost same as compared to the normal annual rainfall.

Table 3: Annual Rainfall Data (2002-2011). (mm)

Taluka	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**Avg.**
Chandrapur	776	1266.9	595.6	1545.1	1233.5	1595.6	1379.7	571.6	1553.8	1229.9	**1174.77**
Mul	901.9	900.3	850	1369	1179.6	1400.4	1055.2	704.3	1590	849.8	**1080.05**
Gondpimpri	864.1	1136.3	852.8	1256.4	1279.6	1452.6	1236.7	669.8	2150.6	983.8	**1188.27**
Varora	805.2	1134.6	624.9	1591	1422.5	1323	990.2	571.7	1547.7	885.4	**1089.62**
Bhdravati	819.8	1071.5	535.3	1705.8	1278	1291.4	1150.5	536.4	1560.2	1164.7	**1111.36**
Chimur	727.3	763.5	623.1	1335.4	1018.7	987.6	546.4	474.9	1249.1	1180	**890.60**
Bramhpuri	761.7	1085.7	936	1525	1159	2061.8	890.1	942.5	1755.9	1083.8	**1220.15**
Nagbhid	659.3	1096.6	909.7	1523.9	964.7	1406.1	877.8	1384.9	1686.2	982.2	**1149.14**
Sindhewahi	823.8	1052.3	884.8	1446.1	1139.7	1586.5	1016.1	907.6	1609.2	1174.1	**1164.02**
Rajura	1017.1	1180	518	1365.1	1287.6	1312.8	1113.9	548.9	1736.6	810	**1089.00**
Korpana	961.3	1751.8	603	1255.4	1221.4	919.1	1035.8	547.8	1230.8	903	**1042.94**
Savali	660.4	909.2	926.8	1633	1527.6	1519.6	986	763.1	1747.6	1121.4	**1179.47**
Ballarpur	785.8	1124.2	496.4	1512.6	1310.8	1958.6	1418.8	513.2	1780.3	897.2	**1179.79**
Pombhurna	630.1	1172.2	847	1326.7	1206.8	1397	964	619.8	1342.3	949.4	**1045.53**
Average	**799.56**	**1117.51**	**728.81**	**1456.46**	**1230.68**	**1443.7**	**1047.23**	**696.89**	**1610.02**	**1015.34**	**1114.62**

(Source: www.agri.mah.nic.in)

3.0 Geomorphology and Soil Types

Chandrapur district can be divided into two physiographic regions i.e., plane region in valleys of Wardha, Penganga and Wainganga Rivers and Upland Hilly Region. The plane region is made up of widely spread and flat terrain occurring mostly along Wardha River. In Wainganga valley flat terrain exhibits rolling topography with residual hills in the southern part, while in the northern part (Brahmapuri taluka) wide alluvial flood plains are observed. In Penganga valley, flat terrain covers very little area in south western part of the district. The upland hilly region lies between Wardha and Wainganga rivers comprising parts of Warora, Chandrapur, Mul and Brahmapuri talukas. The south western part of the district in Penganga basin and covering parts of Rajura and Chandur talukas exhibit hilly topography. The entire area of the district falls in Godavari basin. Wardha. Wainganga and Penganga are the main rivers flowing through the district. These three rivers along with their tributaries rise in the upland within the district and drain the entire district.

Different types of soils are observed in the district and each type supports a well defined cropping pattern of totally different types. The soils of Wardha and

Wainganga valleys are most fertile. The different types of soils occurring in the district are locally called as Kali, Kamhar, Morand, Khardi, Wardhi, Retari, Bardi and Pandhari. Out of above Morand is the most common soil occuirng in the district and is suitable for irrigation due to its loamy texture, whereas on Wardhi soil paddy growing areas are observed in parts of Brahmapuri, Chimur and Nagbhid talukas.

4.0 Ground Water Scenario

4.1 Hydrogeology

The major water bearing formations in the district are Alluvium, Lower Gondwana Sandstones, Deccan Trap Basalt, Vindhyan Limestone and Archean metamorphics. Amongst these, the lower Gondwana Sandstones, particularly Kamthi Sandstone forms the most potential aquifer. A map depicting the hydrogeological features is shown in **Figure-2**.

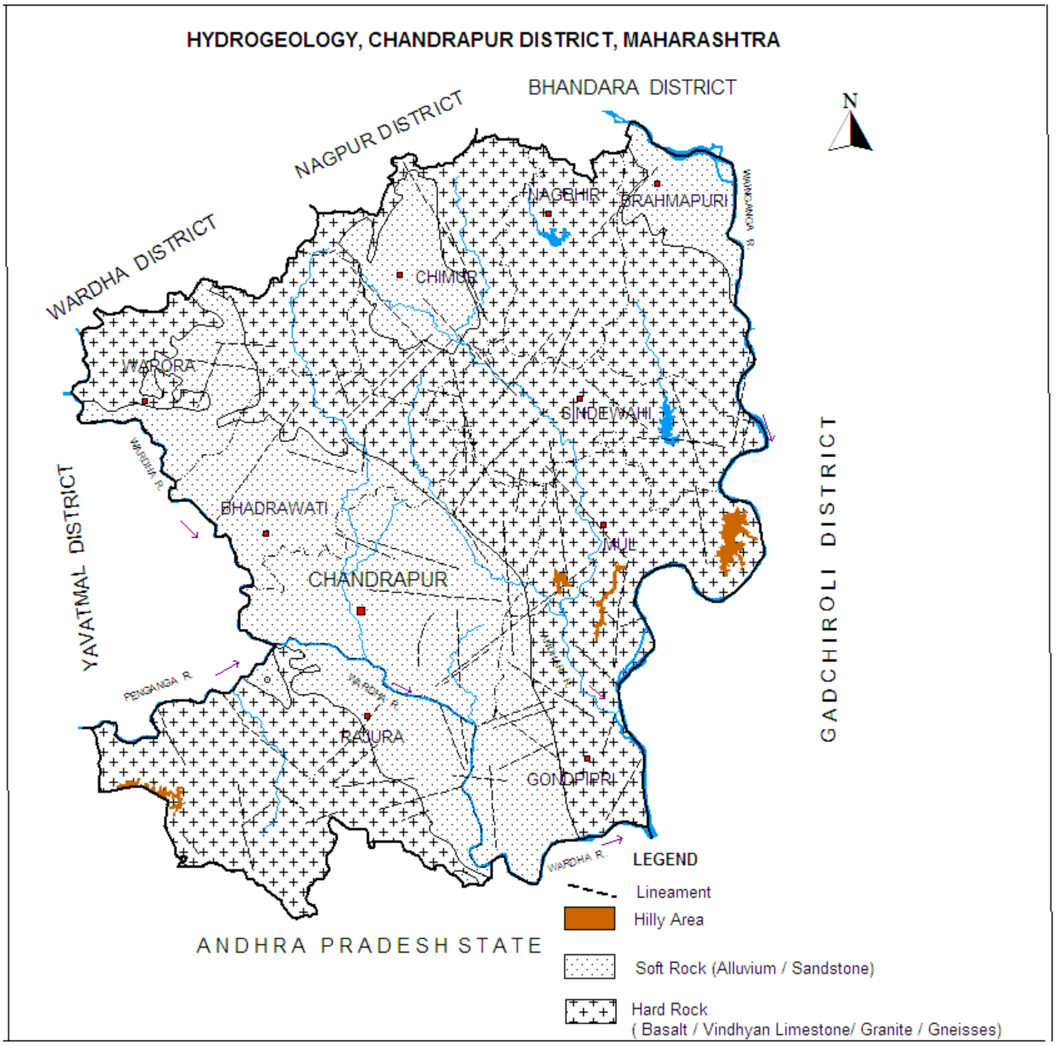

Figure 2: Hydrogeology

4.1.1 Hard Rock Formations

4.1.1.1 Archean Metamorphics

Archeans, which comprise granite and granitic gneiss, occur in most of the eastern part of the district extending north-south from Nagbhid to Gondpipri.

These rocks are generally devoid of primary porosity, but weathering, jointing, fracturing, shearing etc., create secondary porosity, within which the ground water generally occurs in phreatic conditions. The depth of weathering ranges from 4 to 12 m bgl and dugwells are generally tapping this zone with yields of up to 30 m^3/day. Contrarary to the general perception, the possibility of deep seated fracture zone exists in the area because of tectonic disturbances manifested in the form of dykes observed in the area. Therefore borewells in the depth range of 40-70 m bgl are also successful in this formation at suitable places with yield of 1000 to 35000 lph. High yielding dugwells are generally located in fractured granites.

4.1.1.2 Vindhyan Limestone

In Vindhyans, Limestones are water bearing formation while Sandstone due to their hard and compact nature, has poor ground water potential. The Vindhyan sedimentares mainly occur in north central part of the district around Tadoba and Nagbhid in parts of Chimur, Sindewahi, Bhadravati and Nagbhid talukas and in south eastern part of the district in parts of Chandur and Rajura talukas. Limestones as such are massive but wherever they are cavernous and fractured they are capable of holding water and the ground water generally occurs under phreatic condition in these formations and the discharge in general is poor (up to 15 m^3/day). The borewells drilled by State Govt. agencies in the depth range of 30 to 40 m bgl are successful only at few places where discharge of 10000 lph or above has been observed.

4.1.1.3 Deccan Trap Basalt

Deccan Trap Basalt is observed in small area in the north eastern and south eastern peripheral parts of the district and does not form a promising aquifer in the district. Weathered, jointed and fractured Massive and Vesicular Basalt forms the aquifer in the area. Ground water occurs in phreatic conditions within the depth of 10-15 m, however, borewells drilled have shown presence of fracture zones and thus forming deeper confined and semi-confined aquifers at places. The dugwells yield varies from 15-30 m^3/day when favourably located, whereas borewells yield 1 to 3 lps.

4.1.2 Soft Rock Formations

4.1.2.1 Gondwana Sandstone

Gondwana formation comprising of Kamthi and Barakar Sandstone and Maleri and Talchir Shale occupy north-south extending elongated stretch in cental and southern parts of the district in parts of Warora, Bhadravati, Chandrapur, Ballarpur, Rajura and Gondpipri talukas. Sandstone is usually friable and possesses primary porosity due to its granular nature. They are most productive water bearing formations in the district. The ground water occurs under phreatic as well as confined conditions in Kamthi Sandstone up to the depth of 80 to 120 m bgl with thickness varying from 34 to 102 m. Barakar Sandstone occurs below Kamthi formation and three granular zones are observed with cumulative thickness of about 72 m within a 300 m thick sandstone-shale sequence. Comparatively Kamthi Sandstone has more ground water potential with yields of up to 20 lps. The other Gondwana formations i.e., Maleri Series (upper Gondwana) and Talchirs (lower Gondwana) have very poor ground water potential and ground water occurs in phreatic condition.

4.1.2.2 Alluvium

Alluvium of fluvial origin occurs in narrow patches along the banks of Wardha and Wainganga Rivers and consists of clay, silt with lenticular bodies of sand and gravel. Ground water generally occurs under phreatic conditions down to the depth of 10-15 m. The area in the north eastern part of the district near Brahmapuri along the western bank of Wainganga River and having a spread of about 100 sq. km. forms the most potential alluvial area. The Allluvium in this part is occurs down to 30-35 m and the basement is reported to be formed by Granitic Gneisses. The dugwells yield up to 50 m^3/day when favourably located, whereas shallow tubewells yield varies from 5 to 15 lps.

4.2 Water Level Scenario

Central Ground Water Board periodically monitors 55 National Hydrograph Network Stations (NHNS) stations in the Chandrapur district, four times a year i.e. in January, May (Premonsoon), August and November (Postmonsoon).

4.2.1 Depth to Water Level – Premonsoon (May-2011)

The depth to water levels in the district during premonsoon ranges between 1.70 (Chora) and 16.32 (Bhandak) m bgl. Depth to water level during premonsoon has been depicted in **Figure-3**. Shallow water levels within 5 to 10 m bgl are seen in almost entire district except an isolated patch in western part of district in Bhadravati, Warora and Chandrapur talukas where water level are deeper and range between 10 and 20 m bgl. Very shallow water levels of 2 to 5 m bgl are also observed in isolated parts of Nagbhir, Saoli, Mul and Gondpipri talukas. The deeper water levels are generally observed in soft rock areas occupied by Gondwana Sandstone.

4.2.1.1 Depth to Water Level – Postmonsoon (Nov.-2011)

The depth to water levels during postmonsoon ranges between 1.00 m bgl (Rajoli Tukkum) and 13.55 m bgl (Bhandak). Spatial variation in postmonsoon depth to water levels is shown in **Figure-4**. Shallow water levels within 10 m bgl are observed in entire district with dominant range being 2-5 m bgl followed by 5-10 m bgl range. Very shallow water levels of less than 2 m bgl are observed in eastern part of the district comprising parts of Sindewahi, Saoli, Mul and central part of Bhadravati talukas, whereas water levels of 2-5 m bgl are observed in northern, southern and south eastern parts of the district. Water levels in the range of 5-10 m bgl are mainly observed in south eastern part of the district occupying parts of Pombhurna, Chandrapur, Ballarpur, Rajura, Jiwati and Korpana talukas and north-western part of Gondpipri taluka of the district. The deeper water level in the range of 10 to 20 m is observed in south-western part of the Bhadravati taluka. The deeper water levels are generally observed in soft rock areas occupied by Gondwana Sandstone.

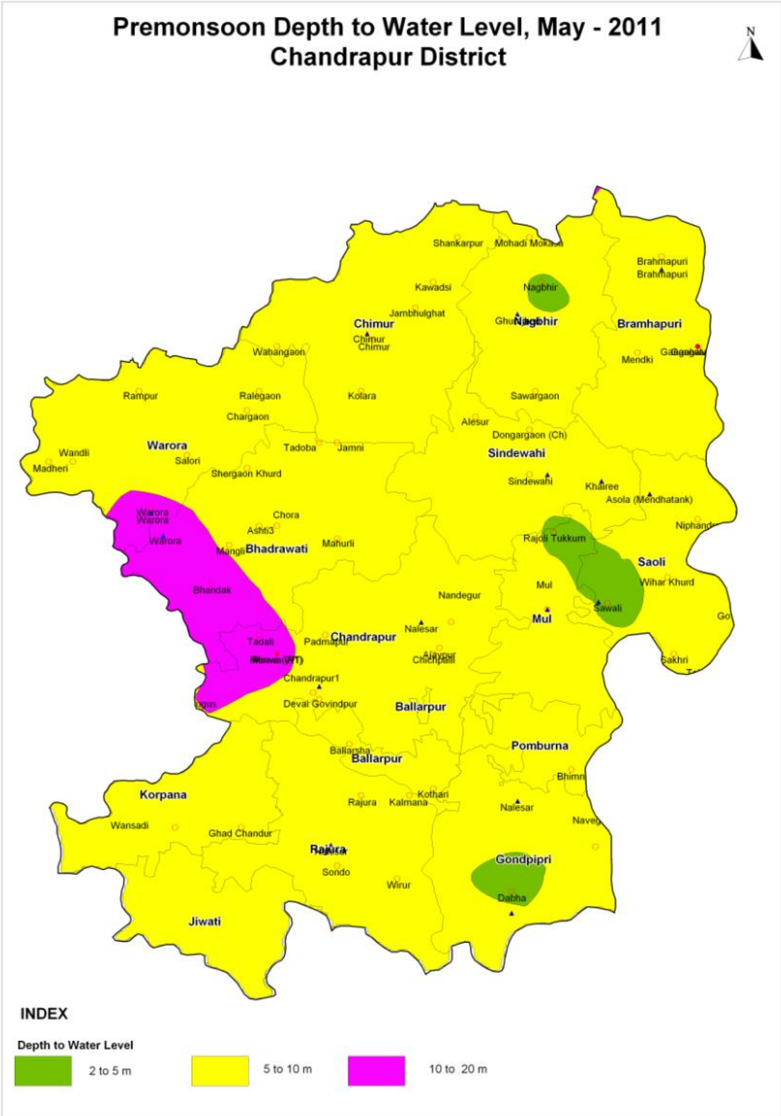

Figure 3: Premonsoon Depth to Water Level (May-2011)

4.2.1.2 Seasonal Water Level Fluctuation– (May-Nov. 2011)

The seasonal fluctuations in water levels have been observed in the range of 0.33 m (Chora) to 10.00m (Sindewahi). Rise in water levels in the range of 2 to 4 m is observed in major parts of the district. Rise of more than 4 m is mainly observed in north eastern parts occupying almost entire Sindewahi taluka and parts of Brhmapuri, Nagbhid and Chimur talukas. Rise of 0 to 2 m is observed in isolated patches in central part of Bhadravati taluka and southern part of Gondpipri taluka.

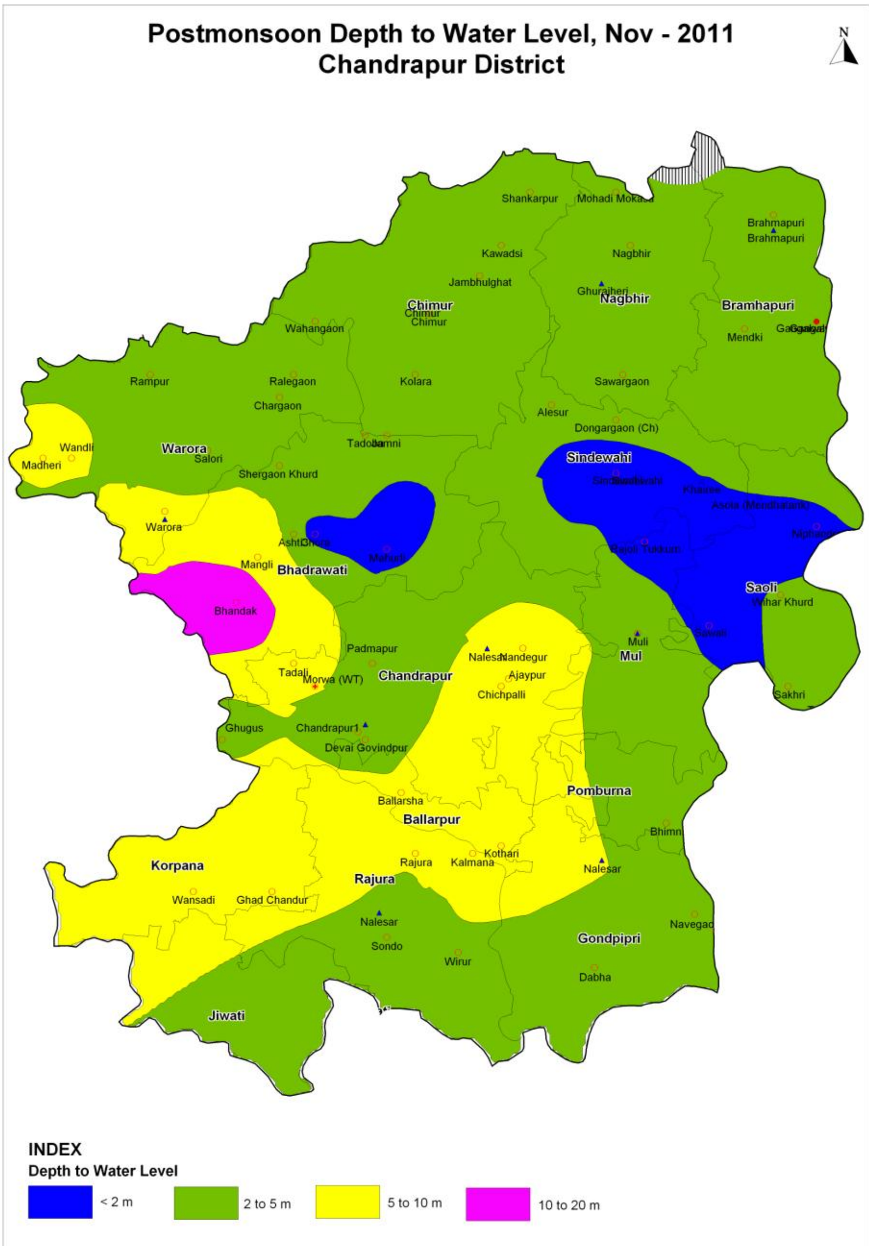

Figure 4: Postmonsoon Depth to Water Level (Nov.-2011)

4.2.1.3 Water Level Trend (2002-2011)

Trend of water levels for premonsoon and postmonsoon periods for last ten years (2002-2011) have been computed for 50 NHNS during premonsoon and 51 NHNS during postmonsoon periods. Analysis of trend indicates that during premonsoon period, rise in water levels has been recorded at 17 stations and it ranges between 0.01 (Madheri) and 0.36 m/year (Bhandak). Fall in water levels has been observed at 33 stations and ranges between negligible (Sonori) and 1.49 m/year (Akaspur). During postmonsoon period, rise in water levels has been recorded at 21 stations and it ranges between 0.016 (Nandegaon) and 1.24 m/year (Warora) whereas at 30 stations, fall in water levels ranging between negligible (Chargaon) and 0.48 m/year (Nandori) is observed. In majority of NHNS, both during pre and postmonsoon periods declining trend of water levels has been observed.

The premonsoon water level trend map was also prepared for the period May 2002-2011 and the same is presented in Figure- 5.

The perusal of map indicates that major parts of the district are showing falling water level trends in the range of 0 to 0.20m mainly in north eastern, central, south western and south eastern parts of the district comprising almost entire Brahmapuri, Nagbhid, Sindewahi, Saoli, Mul, Gondpipri, Jiwati, Korpana, Chandrapur and Warora talukas. The rising trend in the range of 0 to 0.20 m is observed in isolated patches occupying parts of Chimur, Warora, Gondpipri, Rajura and Ballarpur talukas of the district. Thus in major part of the district falling water level trend is observed, which may be due to poor rainfall.

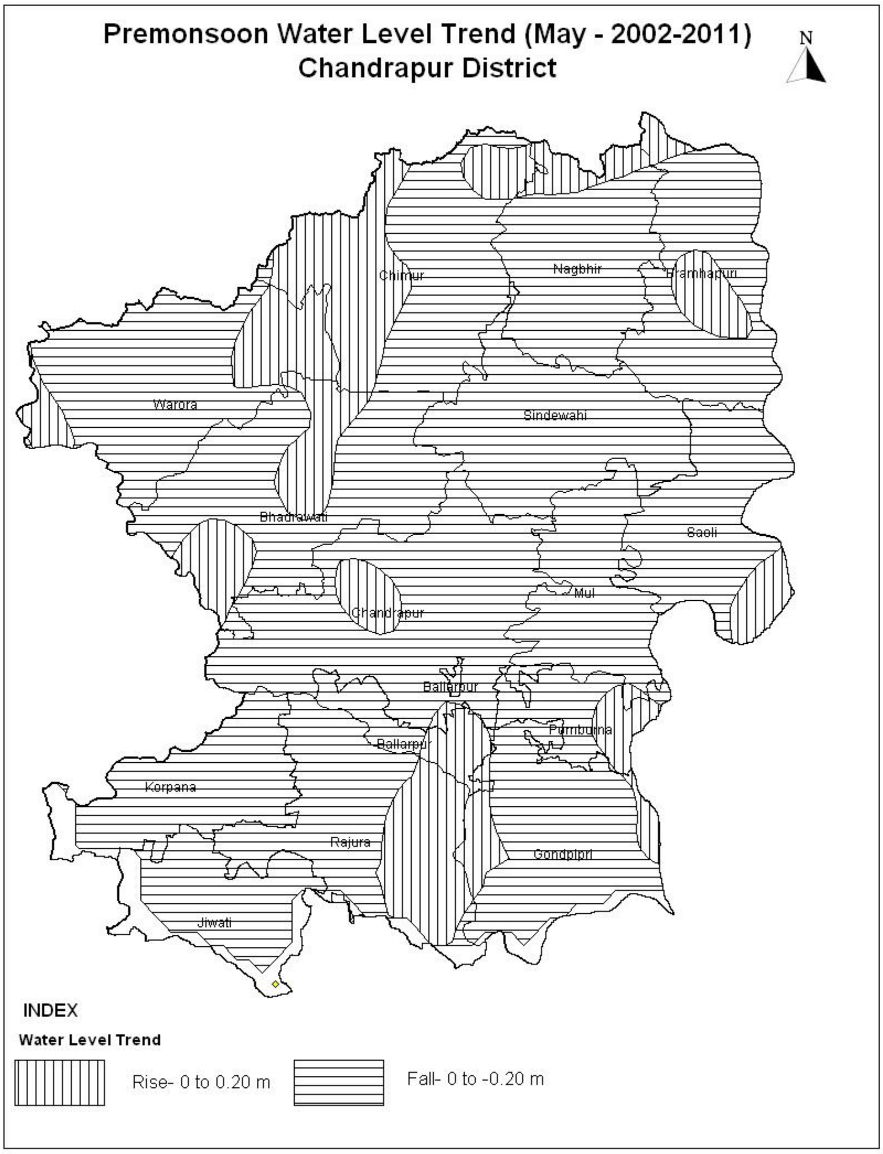

Figure 5: Premonsoon Water Level Trend (May 2002-2011)

4.3 Aquifer Parameters

Pumping tests conducted during RHS in shallow aquifer, reveals that the dugwells tapping sandstone have the permeability or hydraulic conductivity in the range of 0.09 to 2.2 m/hr., whereas the maximum discharge/inflow capacity shows wide variations in the range of 0.50 to about 211 m^3/hr.

During the course of ground water exploration, pumping tests were conducted at Mahakali and Durgapur well field tapping Kamthi and Barakar sandstone. It was observed that the transmissivity varies from 18.00 to 700.00 m^2/day and storativity varies from $3.6x10^{-2}$ to $9.4x10^{-5}$.

4.4 Yield of Dugwells, Tubewells and Borewells

The yields of wells are functions of the permeability and transmissivity of aquifer encountered and varies with location, diameter and depth etc. There are three type of ground water structures i.e., dugwells, borewells and tubewells in the area. However dugwells are the main abstraction structures in the district for ground water development. The yield of such structures varies from 15 to 50 m^3/day. High yielding dugwells are generally located in fractured granites, Gondwana and weathered/fractured limestone occurring in physiographic depressions. The yields of dugwells in basalt are less and the recovery percentage is also very less, whereas dugwells in Archean Metamorphics yields of up to 30 m^3/day are observed. In Alluvium the dugwells are reported to yield about 110 m^3/hr for a drawdown of less than 1 metre near Brahmapuri, however the general range is up to 50 m^3/day. In borewells the yield varies form 1 to 13 lps, whereas tubewells tapping Kamthi Sandstone yield about 15 to 20 lps for a drawdown of 5 to 6 m.

4.5 Ground Water Resources

Central Ground Water Board and Ground Water Survey and Development Agency (GSDA) have jointly estimated the ground water resources of the district based on GEC-97 methodology. The same are presented in **Table-4**, whereas the graphical representations of the resources on the map are shown in **Figure-6**. Ground Water Resources estimation was carried out for 10476.57 sq. km. area out of which 849.79 sq. km. is under command and 9626.78 sq. km. is non-command.

As per the estimation the total annual ground water recharge is 1085.68 MCM with the natural discharge of 56.02 MCM, thus the net annual ground water availability comes to be 1029.65 MCM. The annual ground water draft for all uses is estimated at 150.46 MCM with irrigation sector being the major consumer having a draft of 87.54 MCM. The domestic and industrial water drafts are worked at 62.91 MCM, whereas allocation for domestic and industrial requirement up to next 25 years is 125.83 MCM. The net ground water availability for future irrigation is estimated at 816.27 MCM.

Stage of ground water development varies from 11.37 % (Sawali) to 20.89% (Chimur). The overall stage of ground water development for the district is 14.61 %, which is very low and thus presents plenty of scope for further development. All the talukas as well as the watersheds fall in “Safe” category.

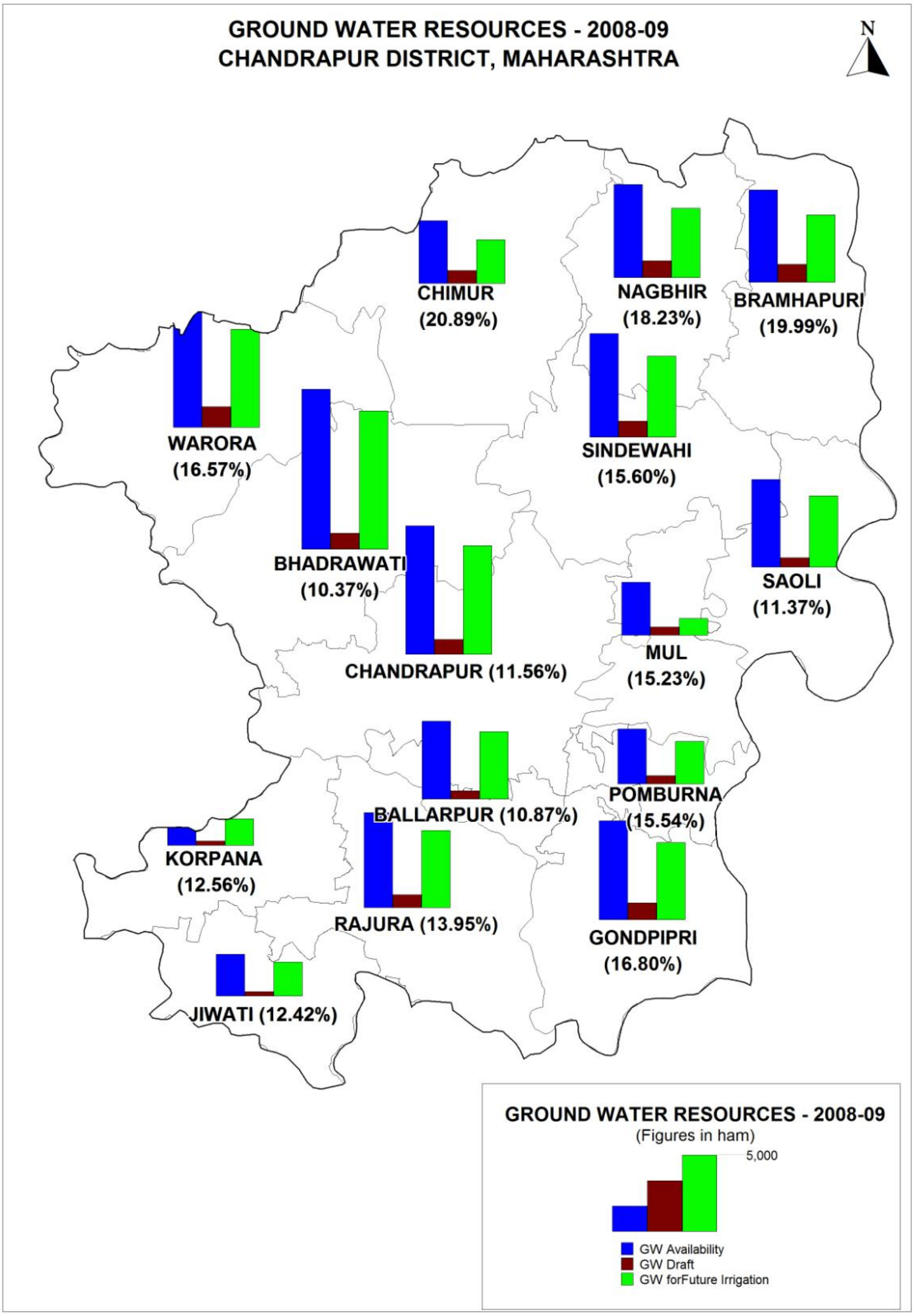

Figure 6: Ground Water Resources 2008-09

Table-4 Taluka-wise Ground Water Resources (2008-09).

Taluka	Net annual ground water availability (ham/yr.)	Existing Gross Ground Water Draft			Provision for domestic & industrial requirement supply up to next 25 years (ham/yr.)	Net Ground water availability for future irrigation (ham/yr.)	Stage of ground water develop-ment (%)	Category
		Irrigation	Domestic & industrial uses	Total				
Ballarpur	6129.26	482.08	184.18	666.26	368.35	5278.82	10.87	Safe
Bhadravati	12543.65	841.67	458.73	1300.41	955.52	10788.62	10.37	Safe
Brahmapuri	7213.93	922.09	519.88	1441.96	1042.18	5265.14	19.99	Safe
Chandrapur	10070.46	733.06	431.34	1164.41	862.69	8474.71	11.56	Safe
Chimur	4910.13	543.53	482.43	1025.95	989.71	3397.63	20.89	Safe
Gondpipri	7776.05	850.72	455.35	1306.07	914.06	6013.45	16.80	Safe
Jiwati	3264.31	179.93	225.45	405.38	453.92	2688.05	12.42	Safe
Korpana	2823.28	169.16	185.54	354.70	332.10	2099.07	12.56	Safe
Mul	4187.10	301.58	336.32	637.89	670.28	3152.02	15.23	Safe
Nagbhid	7323.37	762.71	571.99	1334.71	1167.35	5434.09	18.23	Safe
Pobhurna	4358.53	386.45	291.04	677.49	578.23	3386.28	15.54	Safe
Rajura	7474.66	496.34	546.23	1042.58	1128.43	6015.25	13.95	Safe
Sawali	6854.28	319.76	459.31	779.06	957.23	5562.82	11.37	Safe
Sindewahi	8141.26	662.81	607.08	1269.88	1103.71	6363.69	15.60	Safe
Warora	9895.14	1102.43	537.03	1639.46	1060.03	7707.64	16.57	Safe
District Total	**102965.41**	**8754.31**	**6291.90**	**15046.21**	**12583.80**	**81627.29**	**14.61**	**Safe**

4.6 Ground Water Quality

CGWB is monitoring the ground water quality of the district since the last four decades through its established monitoring wells. The objectives behind the monitoring are to develop an overall picture of the ground water quality of the district. During the year 2010, the Board has carried out the ground water quality monitoring of 22 monitoring wells. These wells mainly consist of the dugwells representing the shallow aquifer. The sampling of ground water from these wells was carried out in the month of May 2010 (pre-monsoon period). The water samples after collection were immediately subjected for the analysis of various parameters in the Regional Chemical Laboratory of the Board at Nagpur. The parameters analyzed, include pH, Electrical Conductivity (EC), Total Alkalinity (TA), Total Hardness (TH), Nitrate (NO3) and Fluoride (F). The sample collection, preservation, storage, transportation and analysis were carried out as per the standard methods given in the manual of American Public Health Association for the Examination of Water and Wastewater (APHA, 1998). The ground water quality data thus generated was first checked for completeness and then the validation of data was carried out using standard checks. Subsequently, the interpretation of data was carried out to develop the overall picture of ground water quality in the district in the year 2010.

4.6.1 Suitability of Ground Water for Drinking Purpose

The suitability of ground water for drinking purpose is determined keeping in view the effects of various chemical constituents in water on the biological system of human being. Though many ions are very essential for the growth of human, but when present in excess, have an adverse effect on human body. The standards proposed by the Bureau of Indian Standards (BIS) for drinking water (IS-10500-91, Revised 2003) were used to decide the suitability of ground water. The classification of ground water samples was carried out based on the desirable and maximum permissible limits for the parameters viz., TA, TH, NO_3 and F prescribed in the standards and is given in **Table-5**.

Table-5: Classification of Ground Water Samples for Drinking based on BIS Drinking Water Standards (IS-10500-91, Revised 2003)

Parameters	DL	MPL	Samples with conc. < DL	Samples with conc. in DL-MPL	Samples with conc. >MPL
TA (mg/L)	200	600	1	20	1
TH (mg/L)	300	600	12	10	Nil
NO_3 (mg/L)	45	No relaxation	10	-	12
F (mg/L)	1.0	1.5	12	10	Nil

(Here, DL- Desirable Limit, MPL- Maximum Permissible Limit)

The perusal of **Table-5** shows that the concentrations of all the parameters except nitrate in most of the samples are below the maximum permissible limit of the BIS standards. Only one sample is having the concentration of Total Alkalinity (TA) more than the maximum permissible limits. It is also seen from the **Table-5** that the potability of ground water in the wells is mainly affected due to the Nitrate (NO_3) as its concentration exceeds more than MPL in 54% of samples. Overall, it can be concluded that the ground water quality in the wells monitored in the district is affected because of high NO_3 concentrations.

4.6.2 Suitability of Ground Water for Irrigation Purpose

The water used for irrigation is an important factor in productivity of crop, its yield and quality of irrigated crops. The quality of irrigation water depends primarily on the presence of dissolved salts and their concentrations. Electrical Conductivity (EC) and Residual Sodium Carbonate (RSC) are the most important quality criteria, which influence the water quality and its suitability for irrigation.

4.6.2.1 Electrical Conductivity (EC)

The amount of dissolved ions in the water is best represented by the parameter electrical conductivity. The classification of water for irrigation based on the EC values is as follows.

Low Salinity Water (EC: 100-250 µS/cm): This water can be used for irrigation with most crops on most soils with little likelihood that salinity will develop.

Medium Salinity Water (EC: 250 – 750 µS/cm): This water can be used if moderate amount of leaching occurs. Plants with moderate salt tolerance can be grown in most cases without special practices for salinity control.

High Salinity Water (EC: 750 – 2250 µS/cm): This water cannot be used on soils with restricted drainage. Even with adequate drainage, special management for salinity control may be required and plants with good salt tolerance should be selected.

Very High Salinity Water (EC: >2250 µS/cm): This water is not suitable for irrigation under ordinary condition. The soils must be permeable, drainage must be adequate, irrigation water must be applied in excess to provide considerable leaching and very salt tolerant crops should be selected.

The classification of ground water samples collected from monitoring wells for irrigation purpose was carried out and given below in **Table-6**.

It is clear from the **Table-6** that maximum number of samples (73%) falls under the category of high salinity water while nearly 23% of samples fall in very high salinity water category. This shows that the ground water in the pre-monsoon season from shallow aquifer in the district should be used for irrigation with proper soil and crop management practices..

Table-6: Classification of Ground Water for Irrigation based on EC.

Type	EC (µS/cm)	No. of Samples	% of Samples
Low Salinity Water	<250	Nil	Nil
Medium Salinity Water	250-750	1	4.0
High Salinity Water	750-2250	16	73.0
Very High Salinity Water	>2250	5	23.0
Total		**22**	**100.0**

4.6.2.2 Residual Sodium Carbonate (RSC)

Residual Sodium Carbonate (RSC) is considered to be superior to EC as a measure of sodicity particularly at low salinity levels. The classification of ground water samples based on RSC values for its suitability for irrigation purpose is shown below in **Table-7**.

Table-7: Classification of Ground Water for Irrigation based on RSC.

Type	RSC	No. of Samples	% of Samples
Good	<1.25	14	64
Doubtful	1.25-2.50	3	14
Unsuitable	>2.50	5	22
Total		**22**	**100**

The perusal of **Table-7** shows that the RSC values of ground water samples collected from the wells is less than 1.25 in about 64% of wells, which reflects that the overall quality of ground water in the monitoring wells is good for irrigation purpose. The high values of RSC (>2.50) were found in 5% of ground water samples collected from Sondo, Dabha, Chora, Chargaon and Ralegaon villages and is unsuitable for irrigation purpose.

4.7 Status of Ground Water Development

Ground water development depends on many factors viz., availability, crop water requirement, socio-economic fabric and on the yield of the aquifers existing in that area.

Ground water is predominantly used for irrigation, as it is the major ground water utilising sector. As per the 4^{th} minor irrigation census data available for year 2006-07, area irrigated by ground water is 372.82 sq. km., whereas the surface water accounts for about 414.81 sq.km. and the net irrigated area is about 787.63 sq.km., thus ground water account for 47%, of net irrigated area. There are about 20922 irrigation dugwells in the district which, create an irrigation potential of 410.02 sq.km., out of which 340.58 sq.km., potential is utilised. In addition to this an irrigation potential of 32.24 sq.km. is utilised through 1655 borewells/tubewells.

State Government has drilled large number of borewells/tubewells fitted with hand pumps and electric motors for rural drinking water purposes in the district. In all G.S.D.A, Government of Maharashtra, in the year 2010-11 was successfully operating 9087 borewells/tubewells fitted with hand pumps and 155 borewells/tubewells fitted with electric pumps under use for water supply in the district.

5.0 Ground Water Management Strategy

Ground water has special significance for agricultural development in the State of Maharashtra. Ground water development in some parts of the State has reached a critical stage resulting in declining of ground water levels. Thus there is a need to adopt an integrated approach of development of ground water resources dovetailed with ground water augmentation to provide sustainability to ground water development.

5.1 Ground Water Development

Ground water development scenario of the district is favourable for further ground water development in years to come as the stage of ground water development for the district is merely 15% and ground water available for future irrigation is about 816 MCM, whereas the area irrigated by ground water is only about 753 sq,km. (2010-11). The development of this resource will increase the irrigation potential of the district manifold and it will be less expensive in time and cost as compared to surface water. Also the district is having many industries especially cement, ceramic, paper industries etc., whose water requirements can be met through the ground water. However the development is to be carried out in a planned manner using suitable ground water abstractions structures depending on the terrain, aquifer potential, quality aspects etc.

In order to develop the available ground water resource for future irrigation dugwells as well as borewells down to the depth of 60 to 80 m are feasible in Deccan Trap, Vindhyan Sedimentaries and Archean Metamorphics. The area occupied by Gondwana Sedimentaries especially Kamthi and Barakar Sandstones are most feasible for tubewells in Warora, Bhadravati, Chandrapur and Rajura talukas. It is recommended to construct tubewells ranging in depth from 60-150 m, which may yield about 15 to 20 lps, however utmost care needs to be taken while selecting screen size, casing and gravel size during the construction of tubewells. In Alluvial areas shallow tubewells of 30 to 40 m depth or DCB of 10 m (dug) + 20 m (bore) yielding 8-15 lps are the feasible structures in parts of Brahmapuri and Chandrapur talukas.

5.2 Water Conservation and Artificial Recharge

Ground water plays vital role for irrigation in the district, as a result the ground water levels are depleting in major part of the district, however the water levels are shallow within 10 m bgl in major parts of the district. To avoid over-exploitation of ground water resources, there is a need to increase irrigation facilities from surface water sources and to conserve water flowing out from area through rivers and nalas at various places by constructing different types of water conservation structures. These structures will not only prevent outgoing surface run-off from the small watersheds, but also will act as artificial recharge structures and arrest soil erosion.

The water conservation and artificial recharge structures needs to be taken up in areas showing falling ground water level trends observed mainly in central part of the district and in small parts of Mul, Gondpipri and Rajura talukas.

6.0 Ground Water Related Issues and Problems

The major parts of the district are showing falling ground water level trends mainly in southern, north western and north eastern parts of the district comprising almost entire Rajura, Gondpipri, Chandrapur, Bhadravati, Warora and parts of Chimur, Brahmapuri and Sindewahi, hence, the water conservation and artificial recharge structures needs to be taken up in these areas. The ground water quality is mainly affected by nitrate as 35% of samples are having high nitrate concentration. Continuous intake of high nitrate concentration water causes infant methaemoglobinamea, popularly known as Blue Babies disease. Thus all the wells used for water supply should be first analysed for nitrate contents and if the nitrate content is found beyond permissible limit the ground water may be used for other purposes than drinking. Adequate sanitary protection to the wells may be provided to control the nitrate contamination. Apart from these, the ground water quality is getting affected due to industrial pollution in and around Ballarpur paper mill, whereas fluoride contamination is also observed in some parts of the district. To study these problems studies have been carried out by CGWB, the details of which are discussed below.

A detailed study of area around Ballarpur Paper Mill, Ballarpur was taken up by CGWB in 2001-02 to study the impact of paper mill effluents on ground water. The study revealed that

- Due to the effluents discharged by the paper mill the colour of Wardha Rriver water has changed to light brownish up to 4-5 km in downstream direction.
- The paper mill effluents Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) values were high and exceed the limit for discharge to inland surface water, thus it requires further treatment. Removal of lignin/cellulose becomes a must in order to bring down the COD level in treated effluent below 250 mg/L also the COD level should be brought down below 30 mg/L before discharging effluent to surface water.

A detailed study of Fluorosis endemic villages falling in 7 talukas of the district was taken up by CGWB in 2000-01 to mainly assess the intensity of the Fluoride contamination in ground water of shallow and deeper aquifers of the area and to bring out theextent of the problem and suggests effective remedial measures. The study revealed that

- High Fluoride concentration is noticed in Vindhyan sediments in parts of Rajura, Korpana and Warora talukas followed by highly weathered granite gneisses of Chimur taluka.
- Fluoride free water supply schemes should be framed exclusively for drinking water purpose by tapping surface water and collector wells, wherever feasible.
- Proper well design in construction of tubewells and sealing of fluoride rich zones based on scientific methods.
- Open wells/shallow borewells should be located in the vicinity of surface water bodies.
- De-fluoridation techniques may be adopted with community involvement.
- As high sodium (which comes from domestic sewage besides from lithology) helps in retention and concentration of Fluoride in ground water, local agencies should make proper arrangement of lined drainage system for disposal of domestic waste.

7.0 Mass Awareness and Training Activities

7.1 M.A.P. and W.M.T.P.

Till March 2009, one MAP had been organised at Anandwan, Warora taluka of the district. The details are given in **Table-8**.

Table-8: Status of MAP.

S. No.	Item	AAP	Venue	Date	Participants
1	MAP	2003-04	Anandwan, Ta- Warora,	18/06/2003	200
2	MAP	2010-11	Mul	27/02/2012	250

7.2 Participation in Exhibition, Mela, Fair etc.

During the MAP at Anadwan and Mul, an exhibition depicting rainwater harvesting model, various ground water related posters, leaflets, literature and technical reports were displayed along with maps of Chandrapur district. The models, maps, posters were explained to the visitors in details.

8.0 Areas Notified by CGWA/SGWA

As per ground water resource estimation all the talukas fall under “Safe” category, hence till March 2011 the area has not been notified either by CGWA or SGWA.

9.0 Recommendations

1. The dugwells are most suitable structures for ground water development in the district. The sites for borewell and tubewells wherever feasible, need to be selected only after proper scientific investigation.
2. Ground water development scenario of the district is favourable for further ground water development in years to come as the stage of ground water development for the district is merely 15% and ground water available for future irrigation is 816 MCM.
3. However in many talukas viz., almost entire Rajura, Gondpipri, Chandrapur, Bhadravati, Warora and parts of Chimur, Brahmapuri and Sindewahi talukas falling water level trend is observed. Hence in these talukas ground water development needs to be coupled with suitable artificial recharge and water conservation measures to augment the ground water resources and adoption of ground water management practices.
4. The development is to be carried out in a planned manner using suitable ground water abstractions structures depending on the terrain, aquifer potential, quality aspects etc.
5. Borewells down to the depth of 60 to 80 m are feasible in Deccan Trap, Vindhyan Sedimentaries and Archean Metamorphics, however their siting/location should be guided by proper scientific survey and tools.
6. The area occupied by Gondwana Sedimentaries especially Kamthi and Barakar Sandstones are most feasible for tubewells in Warora, Bhadravati, Chandrapur and Rajura talukas. It is recommended to

construct tubewells ranging in depth from 60-150 m, which will be capable of yielding about 15 to 20 lps, however utmost care needs to be taken while selecting screen size, casing and gravel size during the construction of tubewells.

7. In Alluvial areas shallow tubewells of 30 to 40 m depth or DCB of 10 m (dug) + 20 m (bore) yielding 8-15 lps are the feasible structures in parts of Brahmapuri and Chandrapur talukas.
8. The major parts of the district are showing falling ground water level trends mainly in southern, north western and north eastern parts of the district comprising almost entire Rajura, Gondpipri, Chandrapur, Bhadravati, Warora and parts of Chimur, Brahmapuri and Sindewahi hence the water conservation and artificial recharge structures needs to be taken up in areas.
9. The scope exists for construction of suitable artificial recharge structures in the district. The structures recommended for the hilly hard rock area in parts of Sindewahi, Mul and Rajura talukas are: contour bunds, gully plugs, nala bunds and check dams. For other hard rock areas, the nala bunds, check dams and KT weirs are suggested. The existing dugwells may also be used for artificial recharge of ground water provided source water is free of silt and dissolved impurities. In soft rock areas occupied by Gondwana and Alluvium, in central part of Chandrapur and south western part of Bhdravati and Warora, where water levels are deep recharge tubewells/recharge shafts can be constructed.
10. The existing village ponds need to be rejuvenated to act both as water conservation and artificial recharge structures.
11. In shallow aquifer potability of ground water is mainly affected by localised nitrate and fluoride contamination, Thus, in these areas, all the wells used for water supply should be first analysed for fluoride and nitrate concentration. Likewise, adequate sanitary protection to the wells may be provided to control the nitrate contamination.
12. Rajura, Korpana, Warora and Chimur talukas of the district are affected by the high fluoride concentration in ground water. To cater to the drinking water requirements of fluoride affected villages, fluoride free water supply schemes should be framed by tapping surface water and collector wells. This should be coupled with educating and creating awareness in public, constructing open wells/shallow borewells should be located in the vicinity of surface water bodies.